Rambles in Science

HOW PHOTOGRAPHY CAME ABOUT

BY

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CHAPTER I

About Light

The word *photography* is derived from two Greek words. If you know the derivation of the word *telegraph* you will know one of the Greek words which goes to make up *photography*. You may remember that the *telegraph* means writing at a distance. *Tele* is the Greek word for distance, and *grapho* means "I write". It is quite evident that the second part of the word *photography* is also from *grapho*, "I write". The first part of the word is from *photos*, meaning light, so that *photography* signifies writing made by light; you know that it is light which makes our photographs.

At one time the art of taking photographs was called *photogenic drawing*, but that was before the word photography was invented.

It will be well to make sure we know what light is. At one time people believed light to be composed of small particles or corpuscles, which were shot off from visible objects, and which entered our eyes, giving rise to the sensations of sight. Now we know that light is something quite different from this earlier idea. We know that light is merely a wave-motion in an all-pervading medium, which we call the æther of space.

In science we call light a *mode of motion*; it is not a real existing thing like matter and electricity. If you were asked to name another mode of motion, I think some of you would suggest heat; heat is not a thing *per se* (by itself). The heat or temperature of anything is due to a vibratory motion of its particles—a mere condition of things. The *radiant heat* sent out by the sun and other sources of heat is composed of waves in the æther of space, just as light is. Indeed the heat waves and the light waves are of exactly the same nature, the only difference being that the heat waves are spaced farther apart than the light waves. The heat waves do not affect an ordinary photographic plate, but we may prepare a plate which will be acted on by these heat waves, which we call *infra-red waves*. Why do we give these waves this curious name? To understand the reason, you must know something about the solar or visible spectrum.

Probably you know that when a beam of light is passed through a triangular prism of glass the light

is spread out in bands of various colours (fig. 1). These are always the same, and at one end of this spectrum you find *red* and at the other end *violet.* Between these you find orange, yellow, green, and greenish-blue, but it is the two extremities which interest us at present.

The different colours are produced by different waves, the difference being in their length, which

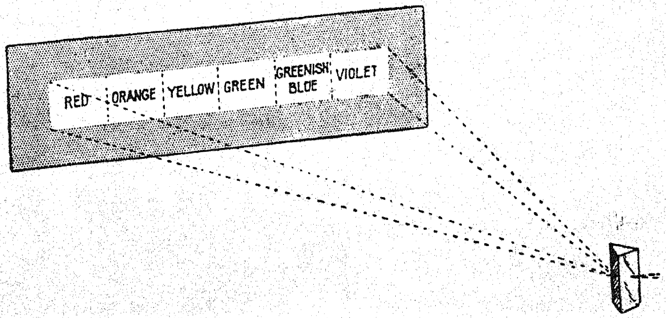


Fig. 1

is their distance apart. The waves producing the sensation of red are farther apart than those producing violet. We call the waves when farther apart *long waves*, and we say that at the violet end the waves are *shorter* or closer together.

If we were to expose a piece of ordinary photographic paper to the visible spectrum, we would find that the waves at the red end had no effect upon the chemicals, but our greatest surprise would be to find that the effect at the violet end did not stop at the

violet, but continued where we could see no light. It is evident that there are waves still shorter than the violet which affect a photographic plate or paper and yet have no effect upon our eyes. We call these short waves *ultra-violet light*, which means beyond the violet.

If we have a specially prepared surface, we may detect waves also at the other end of the spectrum below the red, and we call them *infra-red light*. It is possible to take photographs both by infra-red and ultra-violet light. That is by light which does not affect our eyes. Imagine a man sitting in the dark to have his photograph taken!

What we want to photograph generally are visible objects. We wish to make a record of what we see. We can only see the objects by the waves included in the visible spectrum.

An ordinary photograph is in black and white; it does not deal with colours. It is only within us that light produces different sensations which we call colours. These sensations take place in our brains; outside of ourselves there are only invisible æther waves.

I have called the long waves *red-producing* waves, because if I called them red waves you might imagine that the waves themselves were coloured, whereas they are invisible.

The æther waves cannot produce colours on the chemical surface—they can only darken the surface. A photograph is built up entirely of darker and

lighter patches, according to the amount of light falling on the different parts of the plate.

To help you to realize that colour is merely a sensation, I might show you a bright red board with the aid of a lantern, and while looking at it I could make the board appear jet black. How? By merely altering the æther waves which the lantern is emitting. I can put a screen in the lantern which will prevent any red-producing waves getting out. As no red-producing waves reach the board it can reflect none to your eyes, and so you have no sensation of red. Had I shown you the board in this light at first, you would have said that it was a black board. What I want you to realize is that the colour is not part and parcel of the object, but is dependent entirely upon the æther waves, and that colours are merely sensations produced within us by æther waves which enter our eyes.

You may have heard of colour photography, but the light affecting the photographic plate does not produce the colour. The photograph is still in black and white. The colour sensations are produced by passing the light through dyed starch grains which are embedded in the photographic film.

The black and white photograph is produced by patches of light and shade, and there is an infinite degree of variation between light and no light. The light affects the chemicals on the plate; the darkness does not affect it. The light causes the chemicals to darken, as we shall see later.

It is because the light produces darkness that the result is a negative. A white-faced man becomes a black-faced man in the negative, but when we pass light through the negative with a photographic paper beneath it, then the black face protects the paper, and the result is that the paper remains white where the black face protects it, and we get a photograph of a person with a white face, like the original.

It is a true proverb that two negatives make a positive. If you reverse a thing twice you bring it back to where it was originally.

CHAPTER II

About the Camera

Every boy and girl knows that a camera is used for taking photographs. Snapshot cameras are in common use to-day. We will consider the camera before the photograph, as the camera was invented long before photography. It was the existence of the camera which led to the invention of photography.

If you have thought that the only use of a camera is for taking photographs, you will be surprised to learn that the camera existed hundreds of years before photographs were made. What then was the use of the camera?

The word *camera* is the Latin word for a chamber

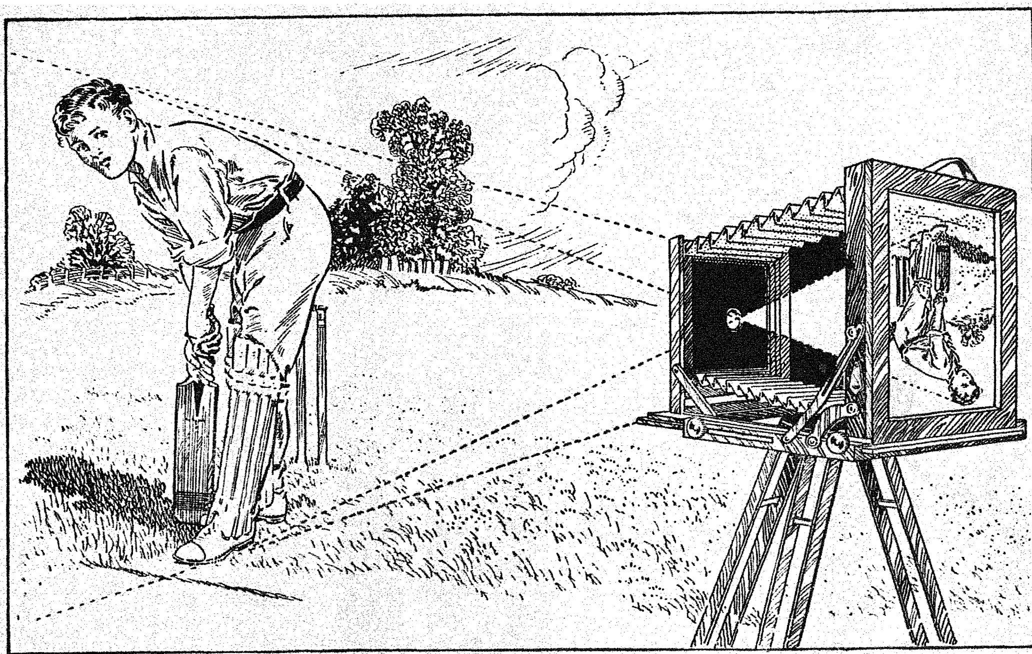


Fig. 2—How the Image is formed in the Camera

or room, and we still use the word in this connexion. When a judge takes a trial in a closed room, shutting out the public, we say that he has heard the case *in camera.*

The first cameras were called *camera obscuras.* These two Latin words signify darkened rooms, and so the first cameras were darkened rooms into which light entered by a hole in a window-shutter. When the light entered the room through the hole it formed an image or picture within the room, a picture of the outward scene in front of the hole. If there were fields and trees in front of the room, a picture of these was formed within the darkened room, but the objects were all upside down. Why? Because they could not be otherwise. Why?

If you look at the accompanying drawing (fig. 2), you will see why the image must necessarily be upside down. You see that although light is reflected from the boy's head in all directions, only the light which passes through the hole in the camera can go to form the image. If you follow the direction of the light leaving the boy's head, you will see that the only light getting from his head into the camera is passing through the hole in a downward direction. As this light must continue in a straight line, it proceeds on its way until it reaches the foot of the camera screen, where it forms an image of the boy's head. In the same way the light which enters the camera from the boy's feet arrives at the top of the screen, and there forms an image of his feet. This gives us the inverted

or upside-down image; the boy appears to be standing on his head.

In the camera obscuras, or darkened rooms, the hole in the shutter had to be kept small in order to have a clear image, and therefore only a small amount of light entered the dark room. It would be an easy matter to cut a larger hole to admit more light, but the light would spread out and blur the image. Indeed if the hole were cut much larger, the light would spread so much that there would be no picture formed. This want of light, making a darkened picture, was a very great disadvantage. But there is a way of admitting more light without allowing the light to spread, and that is by placing a convex lens in the hole. The hole can then be made much larger, and the lens focuses the light to a point; in this way a much brighter picture is produced. The lens was the first improvement in the camera obscura.

The next improvement was to get the picture to appear in its proper position instead of standing on its head. This upside-down picture was a real disadvantage. We do not worry about it in the cameras in which we take photographs, because it makes no difference that the picture is upside down while in the camera, as we can turn it round the other way when we take it out of the camera. But in these early days the picture was only looked at in the camera, so it was a disadvantage that it was upside down.

The introduction of the lens still left the picture inverted; something else had to be done. First of

all the lens was transferred to the roof of the room. This alone would only give them a picture of the sky, but a mirror was added. This was placed at an angle so that it reflected a picture of the scenery around the camera. The image was now formed on the floor, or on a white table arranged to receive it. Then the person desiring to look at the picture could take up a position at the base of the picture as in fig. 3.

These camera obscuras gave entertainment for many centuries. There are still a few existing ones, although most of them have disappeared. You may see one on the Castle Hill in Edinburgh, and in this you may get many interesting views. You can see the tramway cars, the motor cars, and the pedestrians all moving across the white table. The pictures are all in their natural colours.

This camera obscura is a fixture, being a room on the top of a high building. How then can different pictures be produced? The mirror is so arranged that it may be turned round into different positions and thus reflect different scenes through the lens. The mirror's position is altered by pulling cords hanging from the roof.

Camera obscuras were not always fixed in one position. At one time people used to take tents out to the country and erect them as camera obscuras so that they might paint the pictures they saw upon the screen, but more often the camera obscura was a room on the top of a house.

The pictures that are produced have been described

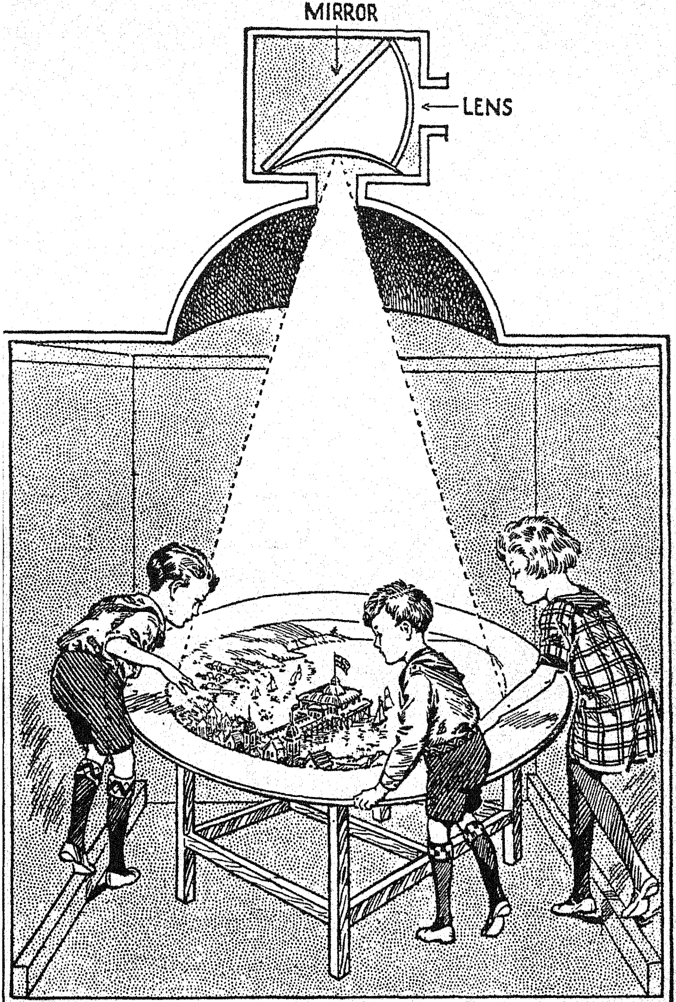


Fig. 3.—Camera obscura

as fairy pictures, and we shall see that it was the beauty of these pictures which led to the desire to fix the pictures and to make them permanent.

These pictures were no doubt produced by accident at first. I have seen such an accidental picture. When I was a boy I came downstairs early one morning when the sun was shining, and I was very much surprised to see a beautiful picture on the ground glass of the inner door, the wooden doors being closed, and forming a dark space between the wooden and the glass doors. It was evident that the picture was being formed by light passing through the keyhole of the outer door.

At that time I knew little or nothing of the behaviour of light, and I was surprised to see the picture standing on its head. There were the fields and the trees which were in front of the house in natural colours, but the trees were all growing downwards, for the reason we have seen already.

Although these pictures are not often produced accidentally in this country, they are quite common occurrences in the East, where they have much brighter sunshine, and many darkened rooms with white walls. All that is required to form the picture is a small hole or a chink in the shutter. Officers who have resided in India have often remarked on these camera obscura pictures which appear without any pre-arrangement.

CHAPTER III

Before the Days of Photography

Some French writers of fiction suggested the idea of light forming pictures, and they made these suggestions long before the invention of photography. In one novel the author tells of Eastern countries; he says that in his dream he was looking at the beautiful picture reflected on the surface of water in a large golden vessel, when suddenly the water froze and the picture became permanent. This was a very simple idea, but there was one of much greater ingenuity, which appears to be what we might call a prophecy of photography as it is practised to-day.

The writer imagined himself in the centre of the great continent of Africa. He was conducted into a room from the window of which he saw a great sea and a stormy sky. He was naturally very much surprised to find the sea in the centre of Africa.

Here is what he said about it:

"I hastily ran to convince my eyes of so improbable a thing. But in trying to put my head out of the window I knocked it against something that felt like a wall. Stunned by the blow and still more with so many mysteries, I drew back a few paces. 'Thy hurry,' said the guide, 'occasions thy mistake. That window, that vast horizon, those black clouds, that raging sea, are all but a picture. The elementary spirits have composed a most subtle matter by the

help of which a picture is made in the twinkling of an eye. They do over with this matter a piece of canvas and hold it over the objects they have a mind to paint. The first effect of the canvas is that of a mirror. But, what the glass cannot do, the canvas, by means of the viscous matter, retains the image. The impression of the images is made the first instant they are received on the canvas, which is immediately hurried away into some dark place. An hour after the subtle matter dries, and you have a picture so much the more valuable that it cannot be imitated by art or destroyed by time.'"

You see how this appears as though it were a prophecy of photography. We set the camera, holding up the prepared plate in front of the objects we have a mind to paint. We expose it to light, the picture is made in the twinkle of an eye, and then we take the exposed plate into a dark place where the picture is made permanent.

Before the days of photography, people had to make all portraits by hand. The general method was to draw the pictures with pen or pencil, or paint them with a brush and coloured pigments. Another plan was to cut out a shadow of the people in black paper, a side view of the face, and then paste this on to a white surface. This old method is sometimes practised even now as a side show at Exhibitions, but none of these methods can compare with the pictures which light itself can draw.

Think of the difference between the production of

a picture by hand and one made by light. To produce by hand a real likeness of the object one has to be an artist, or in any case to have had a long training in the art of drawing.

A picture comprising a landscape with a number of figures in it requires a considerable amount of time and patience. To produce a picture by light, or in other words, to take a photograph, requires no long training, and the actual drawing by light may be done in a fraction of a second.

The general principles of photography are well known. First, there is the focusing of the picture in the camera, so that the image will be sharp where the photographic plate is to be placed. This focusing is most evident in a stand camera in which there is a ground-glass screen upon which the picture is formed. If the picture appears blurred, the photographer moves the front of the camera with the lens nearer to or farther from the back which carries the screen, until the image is quite sharp.

In a snapshot camera there is no ground-glass screen, and the focusing is done by moving the lens into certain positions for the different distances marked on the camera. In small snapshot cameras there is no focusing at all; everything beyond a certain distance is in focus.

After the focusing has been done, the lens of the camera is covered either by a cap or by closing a shutter, which prevents any light entering the camera.

The prepared surface, on which light is to draw

the picture, may be on the surface of a glass plate, or on a celluloid film which may be rolled up in the form of a reel. If a glass plate is used, it must be enclosed in a dark slide until it is desired to expose it to the light. When the dark slide has been placed in the back of the camera, the lid or shutter covering it is withdrawn, but the lens remains closed until it is desired to admit the light to draw the picture.

With the celluloid film there is no need of a dark slide, as the film is protected from light by a dark paper rolled round it.

The time required to make the picture is determined by two factors. In the first place, it depends upon the brightness of the light. A picture taken on a dark day requires a longer exposure than one taken when the sun is shining. Again, a picture taken in the evening requires a longer exposure than one taken at midday, and so on.

If the light is very bright, we may have to stop down the lens by means of a shutter which allows only a small amount of light to pass through a hole in the shutter. These small shutters, with single holes of various sizes, are called *stops*. Another arrangement is to have what is called an iris stop, which has a hole that is opened and shut at will. The idea is taken from the little curtain in the eye which opens and shuts according to the amount of light falling upon it, and which is called the *iris*.

The second factor which helps to decide the time of exposure is the degree of sensitiveness of the

chemicals to light. Some plates are prepared for longer exposure than others.

In the early days the exposure necessary was of long duration, but now the great bulk of photographs are taken by simply touching the trigger of a shutter. However, you may alter the speed with which this shutter opens and closes by varying the amount of tension on its spring. I have known a gentleman when taking a photograph of an abbey to stop down his lens to such an extent that he required to give the plate an exposure of nearly an hour's duration. On the other hand, we have snapshot photographs taken in a very small fraction of a second. When the picture has been thrown upon the photographic plate or film, it must be guarded carefully against any further exposure to light.

If we take the plate into a dark room, we may shine red light upon it, as the ordinary photographic plate is not sensitive to the æther waves constituting red light.

If we examine the exposed plate, we can see no trace of a picture. We say there is a *latent image* or hidden picture, but while the light has affected the chemicals the result is quite invisible. When we place it in a bath of certain chemicals, we see the picture develop gradually on the chemical surface.

If we were to take this developed picture into the light, it would be spoilt, because the remainder of the chemicals which had not been affected by light in the camera would be affected now, and this would

spoil the effect completely. We must therefore dissolve all the remaining chemicals and thus get them off the plate, and after this we can expose the plate to light; we say that we have fixed the image. This fixing is done by placing the developed plate in another chemical bath, after which the plate is well washed to get rid of the chemicals of the fixing bath.

The photographic picture produced by the camera is what we call a negative; a white face appears black, and a black coat appears white. It is just the opposite of what we want. You might consider this to be a great disadvantage, but it is really a convenience. We may get light to print through the clear or white parts of the negative so that a black coat, being white, now is printed black, while a white face, being black in the negative, protects the prepared paper and leaves it white; this is as we wish. We may repeat this printing by exposing more photographic paper under the negative, and from the one negative we may produce any desired number of copies.

It will be of interest to see how all this was discovered.

CHAPTER IV

The Beginnings of Photography

You may have heard of the alchemists, who were the chemists of bygone ages. They practised chem-

istry in the hope of discovering a substance which they called the philosopher's stone, and which when discovered would enable them to turn commoner metals into gold. If they could even succeed in turning silver into gold it would be a most profitable art, provided they could keep the secret to themselves. Alchemy existed until the time of Sir Isaac Newton. We find that great philosopher writing upon this subject to a friend who was going abroad. Newton says in this letter: "If you meet with any transmutations out of their own species into another, as out of iron into copper, out of any metal into quicksilver, . . . those, above all, will be worth noting." The same letter goes on to say: "There is in Holland one, Borry, who some years since was imprisoned by the Pope, to have extorted from him secrets (as I am told) of great worth, both as to medicine and profit, but he escaped into Holland, where they granted him a guard. I think he usually goes clothed in green. Pray enquire what you can of him, and whether his ingenuity be any profit to the Dutch."

The letter is a very long one, and closes with these words, referring to the number of instructions given: "If any of them be new to you, they may excuse the rest; if none at all, yet is my punishment more in writing than yours in reading."

Newton was only twenty-six years of age when he wrote this letter of advice.

There was a German physician who practised alchemy, and one day he made a discovery. His

discovery did not bring him any nearer to finding the philosopher's stone, but it led ultimately to the invention of photography. I hope to persuade you that it did so, although some people say it had nothing to do with photography. This physician's name was Johann Schulze. His surname is pronounced *Schultza*.

One day in the year 1727 Schulze happened to take to the window a glass vessel filled with a pasty mixture of chalk and nitric acid, whereupon he noticed that the light caused the chalky matter to be darkened, wherever the light fell upon it.

He cut out some stencils of letters of the alphabet, by cutting holes to form the letters (fig. 4). When he placed the stencil of a letter over the side of the glass vessel the light could only reach the pasty mixture through the holes in the paper stencil. The light darkened the mixture at such places, and left an imprint of the letter.

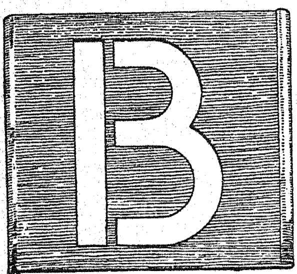


Fig. 4.—Stencil

Schulze cut out stencils of words and sentences, and succeeded in printing these upon the chalky mixture. His method was the same as that of printing a positive copy through a negative.

Schulze desired to repeat his experiment another day, and for this purpose he made a fresh mixture of chalk and nitric acid, but he found that light failed

to darken it. He could not understand this; it was evident that there was some difference in the mixture. Then he remembered that the nitric acid which he used in the first experiment had been used previously for dissolving some silver, and it occurred to him that the silver left in the acid might have made a difference. He took some silver and dissolved it in a fresh supply of nitric acid to try and get the same conditions as on the first occasion. Then he mixed this with some chalk, and tried the effect of light upon it, when he found that it was even more sensitive than the first lot. It was quite evident that the active agent was the silver salts formed by the silver and the nitric acid.

Schulze made many experiments of this kind, and left a record of them.

These experiments were repeated by an English physician in the year 1763. His name was Dr. William Lewis, and he lived at Kingston-on-Thames, which is near London. Dr. Lewis made many experiments with the darkening of silver salts by light, and he wrote down descriptions of these experiments in some note-books. He had an assistant, named Chisholm, who helped him in those experiments.

After the death of Dr. Lewis in 1781, his assistant went into the employment of Josiah Wedgwood, whose name is well known in connexion with the manufacture of a class of pottery which bore his name.

Josiah Wedgwood also bought the note-books

referring to Dr. Lewis's repetition of Schulze's experiments.

Chisholm became tutor to young Tom Wedgwood, son of Josiah Wedgwood, and some years later we find Tom Wedgwood making experiments with silver salts. He coated ivory and leather with the silver salts, and then exposed the prepared surface to the action of light, placing over the surface a drawing made on glass. He found that he could produce a faithful copy of the drawing by the darkening of the parts of the paper on which the light fell.

I think that Chisholm forms a clear connecting link between Tom Wedgwood, Dr. Lewis, and Schulze.

There was another source through which Tom Wedgwood probably heard about the silver salts, and that was through the meetings of the Lunar Society.

This was a very select society of eminent scientific men, and was composed of about eight members, among whom were Josiah Wedgwood and Erasmus Darwin, who was the grandfather of Charles Darwin, whose name is so intimately known in connexion with the subject of evolution. Another member was James Watt, who invented the practical steam-engine in which steam is the driving force; also Sir William Herschel, who may be described as the founder of stellar astronomy.

The Rev. Dr. Joseph Priestley was another member of the Lunar Society, and it is probable that Tom Wedgwood heard something of the action of silver

salts from this clergyman, who was a distinguished chemist, and who read several papers to the society on the chemical action of light. It was Priestley who discovered the gas oxygen. This society, though called the Lunar Society, was not formed for studying the moon. Its only connexion with the moon was that its meetings were held on the first Monday after the full moon, so that its members might have the advantage of the light of the moon on their homeward journey, there being no street lamps in those days.

The meetings were held in the houses of the different members, and there is little doubt that Tom Wedgwood would be present at the meetings held in his father's house. Even if he were not, Chisholm and the note-books were probable sources of information regarding Schulze's experiment.

In 1790 we find Tom Wedgwood getting Sir Humphry Davy interested in the matter. You know that Davy was a very distinguished chemist, and the inventor of the Davy safety lamp for mines, which device was a great safeguard against the explosion of gas exuded from the coal seams. Davy and Wedgwood collaborated in writing a paper entitled "Copying Paintings made on Glass", and this was read at the Royal Institution in London in the year 1802.

Their ambition was to make permanent the image of the camera obscura, but they did not succeed. They were successful in getting light to fix the images

produced by a solar microscope, which might be described as a magic lantern in which the source of light was daylight. It did not throw a large image on a lantern sheet, but merely a small image on a sheet of paper. They took a piece of paper soaked with silver salts, and placed it so that the image fell upon the prepared surface, and they found that they could entrap the image. Their difficulty was that they could not make it permanent. When the picture was exposed further to light the whole surface became darkened, so that the picture disappeared.

We know now that all that was necessary was to wash the paper in a solution of common salt, which would have removed the silver salts which had not been affected by light.

Davy and Wedgwood knew wherein the difficulty lay, for they wrote in their paper: "No attempts that have been made to prevent the uncoloured part of the copy being acted upon by light have as yet been successful."

You may be surprised that so great a chemist as Sir Humphry Davy did not succeed in overcoming the difficulty, but I think the reason why he did not was that he was engaged with other problems which seemed of very much greater importance. In any case, this difficulty caused them to let the matter drop.

CHAPTER V

A British Invention

It is interesting to note that photography is a British invention. It is true that an interesting method known as *Daguerreotypy* was invented on the Continent and was practised in this country, but it did not play any direct part in the invention of photography as it is practised to-day. We shall consider the invention of Daguerreotypy later, and in the meantime follow up the evolution of photography in this country.

The next person to take an active part in the subject was William Henry Fox Talbot. He was a grandson of the Earl of Ilchester, and was fond of travelling on the Continent. When he was in Italy, he desired to make some pictures of Lake Como. He knew of an instrument which was called a *camera lucida*. It was more like a telescope than what you know as a camera. It did not produce an image on a screen, but when you looked through the telescope it formed an image on the eye. There was a glass prism in the instrument, and this bent the rays of light so that the person using the instrument saw the image not where it actually was, but as though it were on a sheet of paper placed on the table below the instrument, as is shown in the accompanying drawing (fig. 5).

The purpose of the camera lucida was to enable the person using it to draw the picture by tracing around the image which appeared to be on the paper. You will understand that there was not a real image on the paper. If you were sitting beside the person

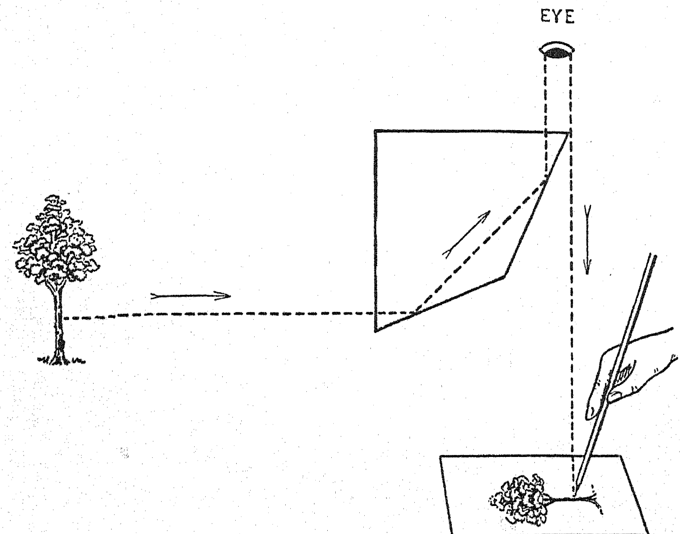


Fig. 5.—Camera lucida

using the instrument you would not see a picture on the paper; only the person saw the picture there instead of right in front as it would have appeared but for the action of the glass prism.

Fox Talbot tried to draw the Lake Como with the aid of a camera lucida, but he failed. Here is what he said about it: "When the eye was removed from the prism—in which all looked beautiful—I

found that the faithless pencil had only left traces on the paper melancholy to behold. I came to the conclusion that the instrument required a previous knowledge of drawing, which unfortunately I did not possess."

Then it occurred to him that it might be easier to trace the picture produced by a camera obscura, in which there was a real image upon the paper, but again he failed, and here is what he said: "It baffles the skill and the patience of the amateur to trace all the minute details visible on the paper, so that in fact he carries away with him little beyond a mere souvenir of the scene, which, however, has its value, when looked back to in long after years."

It occurred to him that he might get light itself to fix the image. He speaks of the camera obscura images in this way: "The inimitable beauty of the pictures of Nature's painting, which the glass lens of the camera throws upon the paper in its focus—fairy pictures, creations of a moment, and destined as rapidly to fade away."

Fox Talbot argued that if you divest the camera picture of the ideas which accompany it, and consider only its ultimate nature, it is but a succession or variety of stronger lights thrown upon one part of the paper and of deeper shadows on another. . . . If it were only possible to prepare a paper in some manner so that it would be acted upon by light falling upon it, might the variegated scene of light and shade not leave its image or impression behind?

We have seen that it was Fox Talbot's ambition to fix the image of the camera obscura. He determined to make a trial of this as soon as he should return home. This was in the year 1833.

His first attempt was in 1834, but in these first experiments he did not use a camera; he merely tested the darkening of the silver salts in the same way as Davy and Wedgwood had done. He placed pieces of lace, leaves of plants, and small objects, over the prepared paper, and got negative impressions of these. He was disappointed to find how slow the darkening process was; it was much too slow to be of any use in recording the picture of the camera obscura, in which the light was very feeble compared with full daylight. You remember that all the light which goes to make up the picture in the camera obscura has to pass through the lens on the roof.

Fox Talbot set himself the problem of finding some means of making the chemical surface more sensitive to light.

In one of his experiments, in which he had coated the paper with alternate brushings of silver nitrate and common salt, he observed that the paper was much more sensitive to light around the edges of the paper. He thought it possible that the salt solution was not so strong around the edges, so he tried a weaker solution of salt over the surface of the paper, and he found this a great improvement.

We know now that if the salt solution had been

very strong it would have destroyed the silver salts altogether.

Of what use was the salt?

Those of you who know what common salt is will remember that its chemical name is sodium chloride or chloride of sodium. As its name implies, it is made up of two elementary substances called sodium and chlorine.

When the atoms of sodium are linked together to form sodium, they become a metal which has very peculiar properties. It is very much softer than lead; so soft that you can very easily cut it into pieces with a penknife. But it has a much stranger property than that. If you place a small piece of it on a damp surface, the metal catches fire and actually burns. This is due to the oxygen of the water uniting very energetically with the atoms of the sodium and producing heat.

The other elementary substance, chlorine, which goes to the making of common salt, is a gas. Not a gas you would like to breathe. It is heavier than air, and you may pour it from one vessel to another without losing much of it.

When the atoms of these two elementary substances, sodium and chlorine, are united together they form salt, which you know has none of the strange properties possessed by the elements when by themselves.

I have told you of these things, because I wish you to realize what happened when Fox Talbot brushed

the surface of the paper with alternate solutions of common salt and silver nitrate. One of the things which happened was this. The atoms of silver united with the atoms of chlorine and formed silver chloride, and this was more sensitive to light than the silver nitrate.

With these more sensitive chemicals, Fox Talbot tried a sheet of prepared paper in a camera or dark box, and this experiment met with some success. He tells us that in his first attempt in the camera he tried to take his residence, Lacock Abbey, but he says: "The outline of the roof and chimneys against the sky was marked enough; but the details of the architecture were feeble, and the parts in shade were left either blank or nearly so."

With this improved paper he obtained quite a good photograph of the mansion. This was in the year 1835.

We have many of Fox Talbot's photographs existing to-day, but these were made on a still more sensitive paper which he succeeded in making at a later date. Unfortunately, none of these very early pictures have been preserved. They would seem of little value to him after hitting upon the greatly improved method, but they would have been of great interest to us now, especially from an historical point of view.

The reason why we have copies of his later photographs is that he published two books, and pasted his photographs into these. He had no means of showing

the pictures except by actual photographs, as no method of printing these in the printing-press had been invented at that time.

Among the plates in this book you will find two of Fox Talbot's photographs which have been reproduced by machinery, and we shall see later how this is done.

One of Fox Talbot's books is called *The Pencil of Nature*, and its existence is well known to those interested in the history of photography. I have seen two copies of it, one of which is in the library of the British Museum, and the other in the library of the University of Glasgow. In the latter copy the photographs are in a much better state of preservation; in the former they are much faded. Probably the prints had not been so well fixed by the chemicals.

When studying the subject in the library of the Patent Office in London, I came across the second book, of which I had not heard. It is entitled *Sun Pictures in Scotland*, and it is from that book that the photographs have been reproduced for the plates in this book.

CHAPTER VI

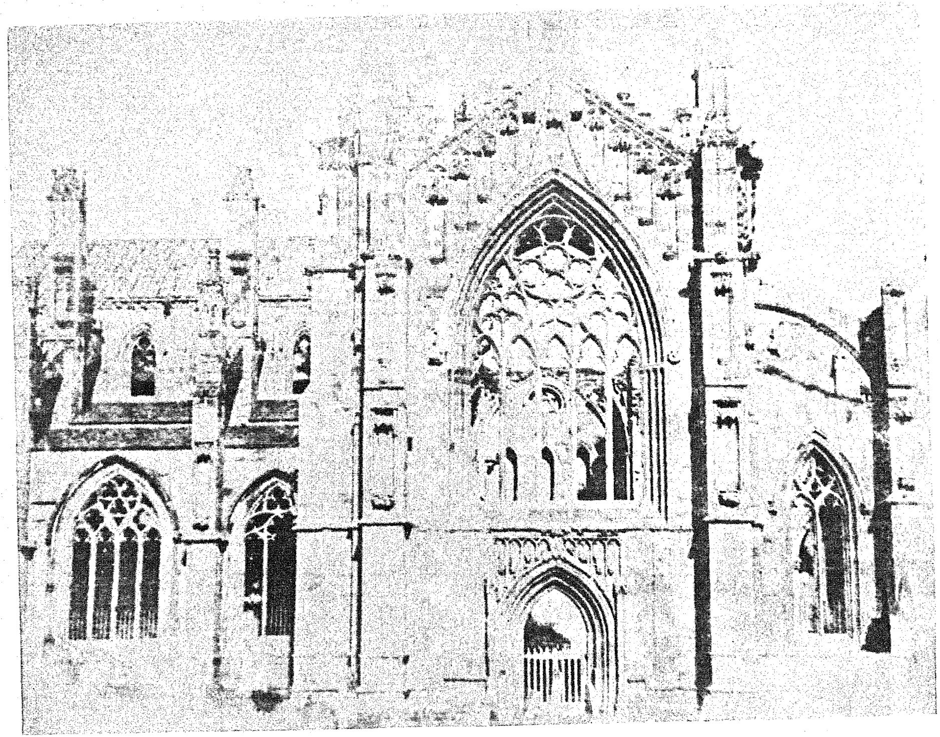
A French Invention

Before following Fox Talbot in his further work, it will be of interest to see what was being done in France.

The beginning of the work on the Continent was due to a Frenchman's desire to get light to do the work done by the lithographers, who required considerable skill and patience to produce the drawings on the lithographic stone from which impressions or printings might be made on paper for the purpose of illustrating books.

The experimenter's name was Joseph Nicephore Niepce. (His surname is pronounced *Nee-eps.*) He began his experiments in 1826, and these had nothing to do with silver salts. It was known that a substance called bitumen of Judea, which could be dissolved in lavender oil, became quite insoluble after it had been exposed to light.

Niepce coated a metal plate with bitumen of Judea and then placed over it a glass on which there was a drawing composed of individual lines; not a picture with ordinary shading—all had to be composed of lines. These lines in the glass would protect the bitumen of Judea, so that the light would not affect the sheltered parts. Therefore the parts under the lines would remain soluble, and the bitumen would



MELROSE ABBEY

From Sun Pictures of Scotland by William Henry Fox Talbot, 1845

disappear when the exposed plate was placed in a bath of oil of lavender. In this way the metal plate would be left bare where the lines of the drawing had been, and the bare part of the metal would represent the lines composing the drawing. Niepce then placed the metal plate with its bitumen covering in a bath containing an acid which would eat its way into the metal, but it could only reach the metal at these exposed lines. The remainder of the plate was protected by the bitumen. The back of the metal plate could not be attacked by the acid, as Niepce took the precaution of covering it with a varnish so that the acid could not reach it.

We shall see later that it was these early experiments of Niepce which led on to the invention of printing photographs by machinery. Meantime we wish to see how photography was invented in France, and we shall see that it was on a principle entirely different from the British invention.

Having succeeded in getting light to print copies of drawings by means of bitumen of Judea, Niepce next formed the desire to get light to make the pictures in the camera obscura permanent. All this was attempted before Fox Talbot became interested in the subject, and was quite unknown to him, as the experiments were conducted in the country near Paris.

Another Frenchman, Jacques Mandé Daguerre, became possessed of the same desire to fix the images of the camera obscura. Daguerre was a scene-painter in Paris, and he used the camera obscura in obtaining

his pictures. He became so enthusiastic in his desire to get light to draw his pictures that his wife thought he had lost his reason. She was so alarmed that she consulted the distinguished French chemist, Dumas, concerning her husband's sanity.

It so happened that Niepce and Daguerre both went to the same optician's shop in Paris to purchase materials for their experiments. The name of the optician was Chevalier. One day he suggested to Daguerre that he should write to Niepce, who was also trying to fix the image of the camera. Thinking that together they might be better able to solve the problem, Daguerre did write. Niepce thought the letter came from some rascal who was trying to find out his secret, so he paid no attention to the letter. A year later Daguerre wrote again, and Niepce replied on this occasion. This led to a meeting and later to a partnership between them.

Chevalier tells us of a very interesting incident which occurred before either Niepce or Daguerre had met with any success. The optician tells us that one day a very shabbily dressed young man came into the shop and asked the price of a certain lens which was being shown in the window. When Chevalier told him the price the young man seemed very much disappointed, and was about to leave when the optician asked him if he might inquire for what purpose he desired the lens. The youth said he had succeeded in fixing the image of the camera, but that his apparatus was very rough. Chevalier thought to

himself that this was another poor fool who was aiming at the impossible, and probably his face was expressive of his thoughts, for the young man took from his pocket a rather shabby pocket-book, and from this he took a picture and laid it on the counter. The optician looked at it and was amazed. There was no doubt that this youth had succeeded in making the camera picture permanent. The picture was quite different from a drawing.

When asked how he had been able to do this, the young man drew from his pocket a bottle containing a fluid. He said his success was due to that, and he left the bottle with Chevalier, promising to call back again.

Nothing further was ever heard of the young man, and we have no means of hearing what his fate was. There seems to be little room for doubt about this being the first photograph ever taken, and it is a great disappointment that it was not preserved.

Chevalier handed over the bottle of liquid to Daguerre, who could make nothing of it. Probably he did not know how to use it.

It has always seemed strange to the present writer that Niepce and Daguerre entered into partnership, as their methods were entirely different. Indeed, there seems to have been no advantage derived from the partnership. It is interesting and gratifying to learn that when Daguerre did meet with success, he kept faith with the old partnership, even although Niepce had died; he took Niepce's son into partnership.

The only similarity between Daguerre's and Niepce's methods was that they both used metal plates, but Daguerre did not continue Niepce's process of bitumen of Judea. He used a coating of silver compound on the metal plate. He met with poor success for a long time. The light made so little impression on the chemicals that it required an exposure of several hours in order to get any real effect.

CHAPTER VII

A Good Fairy

We have seen that the light made so little effect on Daguerre's plates that it was necessary to make an exposure of several hours. During these hours the light and shade of the picture would change, so that he could not hope to obtain a good picture.

He was still plodding on making one long exposure after another, always trying to obtain a better picture, when something happened.

He had set up his camera to try once again to get a picture with good sunlight, and on this occasion the sun was very soon clouded over. This was disappointing after Daguerre had taken the trouble to prepare his plate.

Of course, the metal plate itself would not be wasted; it could have a new chemical surface given to it again. Daguerre put the plate away in the

cupboard to wait another trial. Now, although this darkening of the sun was at the time a disappointment to Daguerre, it led to his success. How could that be?

The following morning when Daguerre thought to make another trial, he opened the cupboard to take out the spoilt plate, and to his great surprise he found upon it a beautiful picture of the scene he had intended taking on the previous day. His joy knew no bounds. He had difficulty in believing his eyes, but there was no doubt about the beauty of the picture. It was like a fairy tale, but who was the good fairy? Daguerre must try to find out.

He made another short exposure with a plate prepared as on the previous day, and then put the plate into the same cupboard, and left it there overnight. We can imagine his impatience to see the result the following morning. Would there be another picture? Next morning on opening the cupboard he found another beautiful picture; there could be no doubt that the good fairy was in the cupboard. Daguerre took a look at the contents of the cupboard, and it occurred to him that a dish of mercury might be the good fairy, and that vapour of mercury rising from this might have altered his plate in some way so that the picture appeared.

This could be very easily proved or disproved, and Daguerre made a test of the mercury in this way. He gave another plate a short exposure in the camera; there was no appearance of a picture on taking it

from the camera, but as soon as he held it over a dish of heated mercury the fumes seemed to produce the picture. Again he had succeeded in producing a beautiful picture, and he had discovered the good fairy.

This was Daguerre's discovery of what we call the *latent image*, a hidden picture which was evolved or developed by means of the vapour of mercury. What really happened was that the mercury vapour attached itself to the surface of the prepared plate in exact proportion to the amount of light which had affected the plate while it was in the camera.

When Daguerre saw his first fairy picture, he exclaimed: "I have seized the light! I have arrested his flight! The sun himself in future will draw my pictures."

These pictures, which came to be called daguerreotypes, were really most beautiful. Everyone was interested in them, and they were surprised at the great accuracy of the pictures. One French journal said: "In a view of Paris we can count the paving stones; we see dampness produced by rain; we can read the name on a shop."

Some people imagined that there would be no further work for artists or etchers. Even the great painter, Paul Delaroche, said: "Painting is dead from to-day." We know that this prophecy did not come true, and we shall see later how photography has enabled us to reproduce the artist's painting in the printing press.

While everyone was interested in Daguerre's discovery, they did not think it likely to be a success financially. He tried to float a company to work his process, but people were not willing to risk their money in such an undertaking.

The process was fairly simple. A copper plate was given a polished silver surface, which was made sensitive to light by exposing it to the vapour of an elementary substance called iodine — the same substance as is used by doctors to-day for healing purposes. The iodine and silver atoms combined to form the compound—iodide of silver, and this substance is sensitive to light.

If you were to take this prepared plate and hold it over the vapour of mercury, there would be no effect, but if the iodide of silver were exposed to light, and then held over the mercury vapour, the atoms of mercury would adhere to the plate.

If the iodide of silver on the plate was exposed in the camera, then some parts were affected by light, and other parts representing the shade were not attacked by the light. When this exposed plate was treated with the vapour of mercury, then only those parts affected by the light took up the mercury atoms. In this way a picture was formed representing the light and shade of the scene in front of the camera.

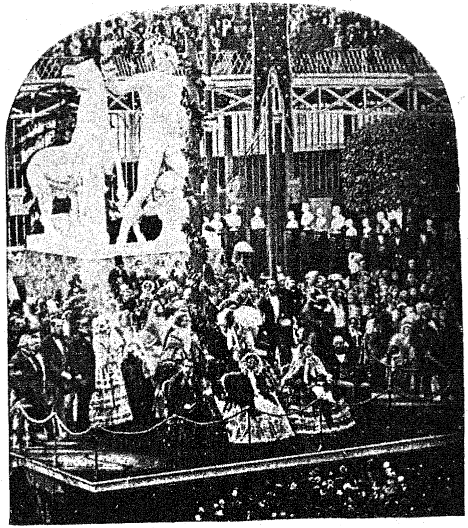
Suppose there had been a man in the outdoor scene. His face would have reflected light into the camera, and so the plate would be affected where the image of his face fell upon the plate, but his black coat would

reflect no light, and so the plate would not be affected at that place. Then some part reflecting only a little light would only have a little effect on the plate, and so on until a true representation of the light and shade of the scene was built up.

Of course, the plate on being taken from the camera had to be carefully shielded from further exposure to light. The treatment with mercury vapour had to be done in a dark room, and then again the iodide of silver which had not been affected with light could not be left on the plate or it would spoil the picture. It was easily removed by washing the plate in a solution of common salt.

If you have seen a daguerreotype you will remember that the metal plate is mounted in a little frame, and protected by a glass lid in order to preserve it; the slightest touch of a finger is sufficient to spoil it.

These daguerreotypes are sometimes confused with photographs which are made on glass by a process known as the Scott-Archer method. On one occasion when I was making a search for some daguerreotypes taken of prisoners, the Chief of the Criminal Investigation Department (C.I.D.) in one of our large cities told me that he had some excellent daguerreotypes. When I went to see them he told me that unfortunately some of the best of them had been broken. Of course, I knew at once that they were not daguerreotypes, as the metal plates would not get broken easily; I found them to be Scott-Archer photographs. You may easily tell a daguerreotype by looking at it from



EXAMPLES OF DAGUERREOTYPES

The example on the left shows the opening of the 1851 Exhibition

different angles. The picture can be seen only when held in certain positions; a Scott-Archer picture may be seen from any angle.

CHAPTER VIII

More about Daguerre

Daguerre heard that Fox Talbot had secured the image of the camera, and thinking that the method was the same as his own, Daguerre announced his own success, but did not divulge his process. The public announcement came about in the following manner.

Daguerre showed his pictures to Monsieur Arago, who was one of the greatest scientists of his time. Arago was greatly astonished at the beauty of the pictures, and being not only a scientist, but one of the leading politicians, he brought the matter before the Chamber of Deputies.

Other men of science became interested in this discovery of Daguerre's, of which Arago spoke in such high terms. It seemed as though the discovery would be of world-wide interest, so a Bill was brought forward in the Chamber of Deputies, requesting the House to grant annuities to Daguerre and his partner.

The original partner, Joseph Nicephore Niepce, was dead, but his son, Joseph Isidor Niepce, had become a partner.

Daguerre could not have had a more able spokesman than Arago. He spoke to a full house, and the members unanimously agreed to grant Daguerre the sum of 6000 francs per annum, and 4000 francs to Niepce junior. As the partnership was an equal one, you may wonder why Daguerre was given a larger sum, but the reason was that Daguerre promised to make public the methods by which he had produced some wonderful panoramic effects which he had shown in Paris.

Here is an extract from Arago's speech to the Chamber of Deputies: "The Daguerreotype demands no knowledge of drawing, and does not depend upon any manual dexterity. Anyone may succeed with the same certainty as the author of the invention. The promptitude of the method is perhaps that which has most astonished the public."

They could not take instantaneous photographs at that time, but what Arago meant was that the process was so very much quicker than that of drawing and painting.

The Bill having been passed by the Chamber of Deputies, it had to go before the Chamber of Peers before becoming law. In this Chamber it was decided that it would not be wise that the process should remain a secret with Daguerre, and that for this reason alone they should grant the annuities and have the process made public.

It is generally supposed that Daguerre did not keep faith with the French Government, because he

took out a patent for his process in Great Britain.

Thinking that there must be some misunderstanding about this, I visited a Library of Patents to see what was actually said in Daguerre's patent. At first I could not find the patent, as Daguerre's name does not appear in the Index. However, I knew the date, and as there were not so many patents taken out in those days as nowadays, I had no difficulty in tracing it. It was taken out by a London patent agent on behalf of a foreigner residing abroad, and in the text he says: "I believe it to be the invention of Messieurs Louis Jacques Mandé Daguerre and Joseph Isidor Niepce, Junior, both of the kingdom of France, from whom the French Government have purchased the invention for the benefit of that country."

From the foregoing it seems evident that Daguerre's understanding of the Bill was that he gave it freely to France, and he considered he was free to patent it in other countries.

Another thing I found was this: The London patent agent applied for his patent before the meeting of the Chamber of Deputies at which Daguerre announced his discovery. The agent says in the text of the patent that it was sealed "on the second day of August, now last past", which is some days prior to the exposition of the said invention or discovery to the French Government at Paris by Messieurs Daguerre and Niepce. I think it is evident from these points which I have mentioned that Daguerre acted quite honestly in the matter.

I have seen a copy of Arago's speech, which is recorded in a small Manual in the Library of the British Museum, and here is what he said. The invention is to be a present "to the World of Science and Art". Historians have taken this to refer to all countries, whereas Daguerre evidently understood that it referred only to France.

His British patent became a source of profit, as licences for the use of his process were granted, and as much as £1000 was paid in order to have the exclusive right in some large cities.

I think the reason for taking out this British patent was because of the existence of the rival process which was being developed in Britain by Fox Talbot.

Studios for the production of Daguerreotypes were opened in 1840, and continued until about 1854, after which the practice of Daguerreotypy gradually dwindled away, and Fox Talbot's method came into practice.

It is amusing to read some of the early accounts of taking portraits by Daguerreotypy. The photographer sometimes painted the face of the sitter with white paint, as he said the flesh did not reflect sufficient sunshine to affect the chemicals on his photographic plate. The sitter had to remain still during an exposure lasting about twenty minutes, and in the first attempts the full sunlight was allowed to fall upon the face. However, the sunlight was passed through a glass tank containing a solution of blue-

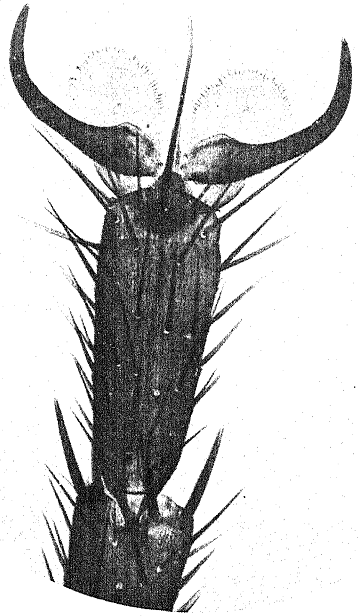


Photo G. H. Rodman, M.D., Hon.F.R.P.S.

A PHOTOMICROGRAPH

A photograph of a fly's foot taken through a microscope so that it is shown one hundred times larger than the actual size.

stone (copper sulphate) in order to absorb the heat rays of the sun.

Part of the photographic instructions were: "A person dressed in a black coat and open waistcoat of the same colour must put on a temporary front of a drab or flesh colour, or by the time that his face and the fine shadows of his woollen clothing are evolved, his shirt will be solarized and be blue, or even black, with a white halo around it."

Another instruction to early photographers was: "The hands should never rest upon the chest; the motion of respiration disturbs them so much as to bring them out of a thick and clumsy appearance, destroying all the representations of the veins on the back, which, if they are held motionless, are copied with surprising beauty."

It is evident that the early photographers aimed at faithful copies, for I came across an early advertisement of a special chair arranged with a staff terminating in an iron ring for supporting the head and enabling it to be held steady during a long exposure. In this advertisement the inventor of the apparatus says: "By simply resting the back or side of the head against this ring, it may be kept sufficiently still to allow the minutest marks on the face to be copied."

Although Daguerre's discovery was made in France, it was in America that the first attempts at portraiture were made.

We have become so accustomed to the idea of

instantaneous photography that it is surprising to read in Arago's speech to the Chamber of Deputies: "Those persons are deceived who suppose that, during a journey, they may avail themselves of brief intervals, while the carriage slowly mounts a hill, to take views of a country."

At the time this speech was made, the quickest exposure possible was about twenty minutes. The amateur photographer of to-day may snap off a dozen photographs as he drives or walks.

CHAPTER IX

More about Fox Talbot

We have already traced the evolution of photography, as it was made in Great Britain, from Dr. William Lewis, who repeated the experiments made in Germany by Schulze. Then the work of Tom Wedgwood and Humphry Davy, followed by the more successful experiments by Fox Talbot. Now we wish to see how the later work of Fox Talbot came about.

His early experiments were with silver nitrate and then silver chloride, as already described. With these the pictures had to be printed out in the camera on a prepared paper, giving him a paper negative. Then Fox Talbot also discovered that there could be

a latent image in his paper negative, and this is how he made the discovery.

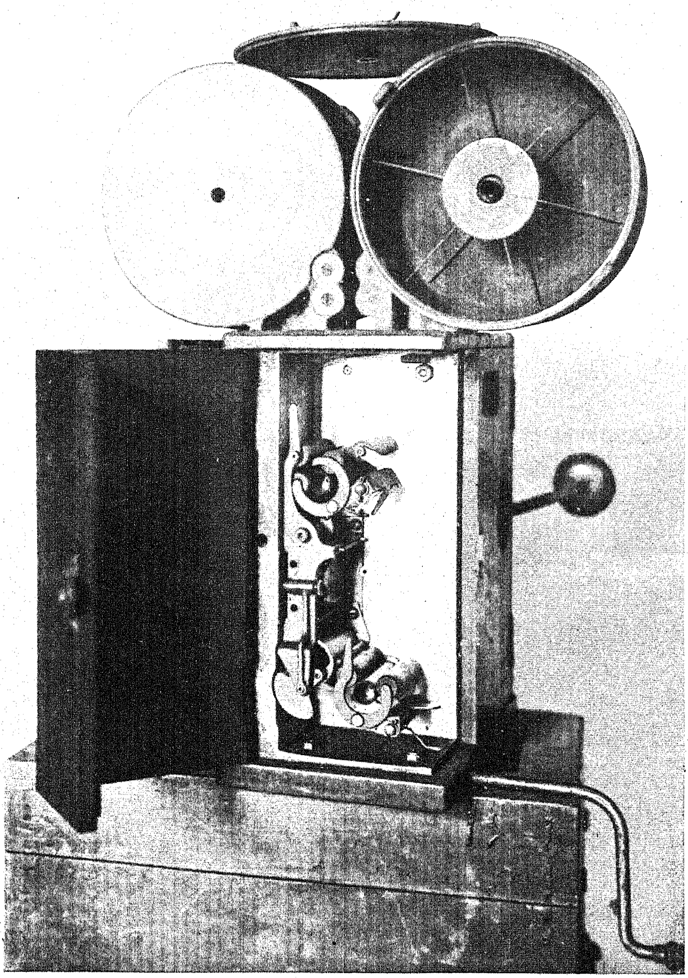
As early as 1834 he had made some experiments with the iodide of silver. He tells us that these experiments were suggested by something Sir Humphry Davy had written, and which he (Fox Talbot) had chanced to come across some time previously.

He says: "I resolved to make trial of the iodide. Great was my surprise on making the experiment to find just the contrary of the fact alleged, and to see that the iodide was not only less sensitive than the chloride, but that it was not sensitive to light at all; indeed, that it was actually insensible to the strongest sunshine, retaining its original tint (a pale straw colour) for any length of time unaltered in the sun. This fact showed me how little dependence was to be placed on the statements of chemical writers in regard to this particular subject, and how necessary it was to trust to nothing but actual experiments; for although there could be no doubt Davy had observed what he had described under certain circumstances, yet it was clear also, that what he had observed was some exception to the rule itself. In fact, further inquiry showed me that Davy must have observed a sort of subiodide in which the iodide was deficient as compared with the silver; for as in the case of the chloride and subchloride, the former is much less sensitive, so between the iodide and the subiodide there is a similar contrast, but it is a much more marked and complete one."

Four years after making these experiments with the iodide of silver, Fox Talbot happened to throw a piece of iodine on to the piece of silver leaf with which he had covered a piece of glass, and he observed that sunlight had an effect on the silver around the particles of iodine. It seemed evident that light did have some effect on the iodide of silver. While Talbot was pondering over this subject he got word of Daguerre's success with the iodide of silver on his metal plate, and so there was no occasion to pursue these experiments further. In any case, they might have led him away from the idea of the negative and the positive prints.

It is interesting to note that Talbot published all details of his process six months before Daguerre made known his methods. Talbot's process went under many names, such as Flourotype, Ferrotype, Chromatype, Chrystotype, Cyanotype, Autotype, Energiatype, Hyalotype, &c. Talbot's own suggestion was Calotype, which means beautiful pictures; and there was yet another name suggested by others, who called it Talbotype, after its inventor.

Talbot gave the name Calotype to his later methods, in which he prepared the paper with silver iodide. Before placing the paper in the camera he washed it over with a solution of silver nitrate and gallic acid. After exposure only a very faint image appeared, but this was greatly improved or developed by a further washing with the same solution. He heated the paper gently, and the image became a dense black.



By courtesy of Mr. Will Day.

EARLY CINEMATOGRAPH CAMERA

Model of a machine called the Biograph Camera which took moving pictures in 1898.

Talbot took out a patent for this process in 1841.

While making experiments with paper prepared in this way, Fox Talbot discovered the latent image or hidden picture. Here are his own words: "The discovery of the latent image and the mode of its development were made rather suddenly on September 20 (1840). This immediately changed my whole system of work. The acceleration obtained was so great, amounting to full one hundred times, that, whereas formerly it took me an hour to take a pretty large camera picture of a building, the same only took now about half a minute. . . . I soon drew up an account of this process, which I named the Calotype."

In a letter to the editor of the *Literary Gazette*, of date 19th February, 1841, Talbot wrote:

"I may as well begin by relating to you the way in which I discovered the process itself. One day, last September, I had been trying pieces of sensitive paper, prepared in different ways, in the camera obscura, allowing them to remain there only a very short time, with a view of finding out which was the most sensitive. One of these papers was taken and examined by candlelight. There was little or nothing to be seen upon it, and I left it lying on a table in a dark room. Returning some time after, I took up the paper, and was very much surprised to see upon it a distinct picture. I was certain that there was nothing of the kind when I had looked at it before, and, therefore (magic apart), the only conclusion that could be drawn was that the picture had unexpectedly

developed itself by a spontaneous action. Fortunately I remembered the particular way in which this paper had been prepared, and was therefore enabled immediately to repeat the experiment. The paper, as before, when taken out of the camera, presented hardly anything visible; but this time, instead of leaving it, I continued to observe it by candlelight, and had soon the satisfaction of seeing a picture begin to appear, and all the details of it came out one after another.

"In this experiment the paper was used in a moist state, but since it is much more convenient to use dry paper if possible, I tried it shortly afterwards in a dry state, and the result was still more extraordinary. The dry paper appeared to be much less sensitive than the moist, for when taken out of the camera after a short time, say a minute or two, the sheet of paper was absolutely blank.

"But nevertheless I found that the picture existed there, *although invisible*; and by a chemical process, analogous to the foregoing, it was made to appear in all its perfection. . . . I know few things in the range of science more surprising than the gradual appearance of the picture on the blank sheet, especially the first time the experiment is witnessed."

From this letter we see that Fox Talbot also discovered the latent image, though not with the aid of a good fairy in a cupboard as had been done by Daguerre.

You may be interested to hear that Queen Victoria

and the Prince Consort were amateur photographers in Talbot's time, and they had a dark room fitted up in Windsor Castle, so that they might develop the paper negatives which they took in their practice of the art of Talbotypy.

CHAPTER X

Further Progress

The next improvement was to have a glass negative in place of a paper one. The glass required some film to carry the chemicals, as they could not be soaked into the glass as was the case with paper.

At first the white of an egg (albumin) was used to form a supporting film, then collodion was tried by Scott-Archer. The collodion formed a nice coating for the glass, and it easily held the sensitive chemicals embedded within it. The collodion plate was used at first in a wet state. I know of amateurs who used to work with wet plates. This was followed by the dry collodion plate, which was much more convenient. The dry plate did not come into practice until 1880.

A much earlier improvement in photography was the invention of a portrait lens, which would admit much more light than previous lenses, and yet produce a nice sharp image.

The next step, which will interest you, was the introduction of a celluloid film in place of the heavier

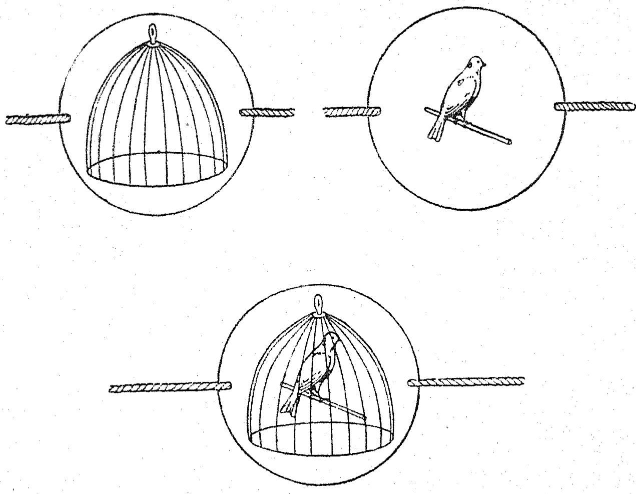


Fig. 6.—Thaumatrope

glass plate. This enabled the sensitized film to be rolled up on a reel, so that a dozen photographs might be taken, one after another, without any of the trouble of dark slides.

It was the introduction of the celluloid film which made it possible to have a cinematograph.

There were in existence several means of showing moving pictures by making drawings of successive stages of movement, and then bringing them rapidly before the eye. One of these was an ancient toy called a *thaumatrope* (fig. 6). It was much simpler than its name appears. Its name is derived from two Greek words, *thauma*, "a wonder", and *trepo*, "I turn". It consisted of turning a cardboard round

quickly. On one side of the cardboard there might be the picture of a bird's cage, and on the other side the picture of a bird. When the cardboard is turned round and round, the eye sees the complete picture of the bird in the cage. You might easily make a thaumatrope for yourself.

Then there was another toy called a *phenakistoscope.* This very formidable looking word is derived from the two Greek words, *phenakistikos*, meaning "deceitful", and *skopeo*, "I view".

Successive positions of a boy skipping, or some other pictures depicting movement, were made on a circular piece of cardboard, and this was mounted behind another disc, in which slots were cut. The

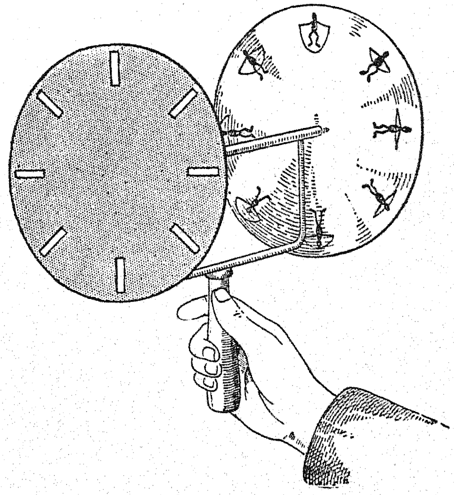


Fig. 7.—Phenakistoscope

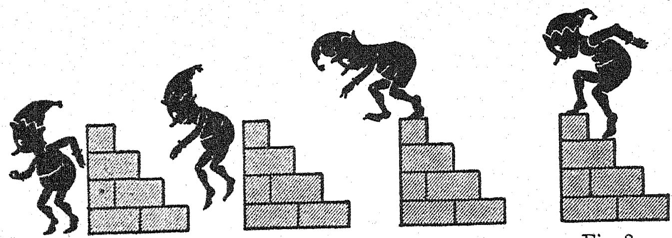


Fig. 8

pictures and the disc with slots were both revolved on a spindle (fig. 7), and the pictures were viewed through the slots, each picture coming into view after its neighbour.

The impression upon the eye was as though the boy moved through the actions of skipping. The quicker the disc was turned, the quicker the boy appeared to move. This toy is not so old as the thaumatrope, which was known to the ancients. The phenakistoscope was invented about one hundred years ago.

It was followed by another toy called a *zoetrope*, and the parents of this word were two Greek words, *zoe*, "life", and *trope*, "a turning".

The accompanying drawing (fig. 9) shows what it looked like. The drum or cylinder contained a long strip of pictures (fig. 8). On looking through one of the slots in the drum, you saw the picture opposite it, and as the drum was turned round, each picture came into view in succession. The little man appeared to run up the steps and jump down from the wall.

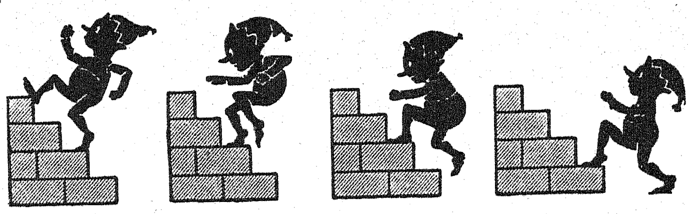


Fig. 8

The reason why I have told you of these toys is that they led to the invention of the cinematograph. It came about in a rather strange way. Two gentlemen in California had an argument as to the positions of a horse's feet while in motion. To decide the point, one of the gentlemen took a series of successive pictures of the horse. He set up a row of twenty-two cameras, and as the horse passed in front of each camera it set off the shutter, which exposed the photographic plate for a moment. The photographs had

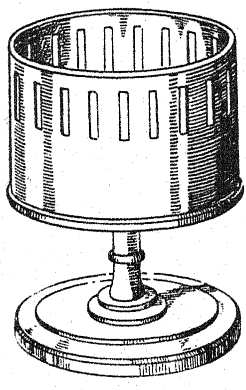


Fig. 9

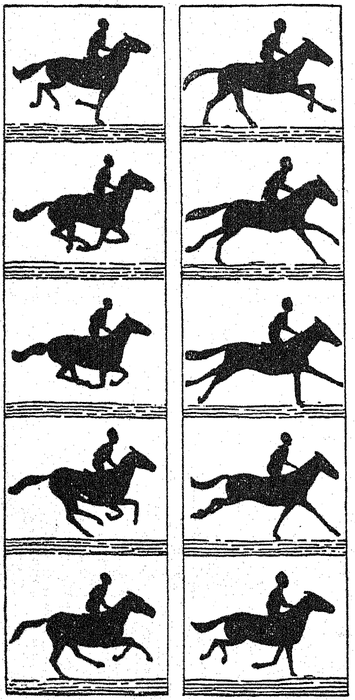
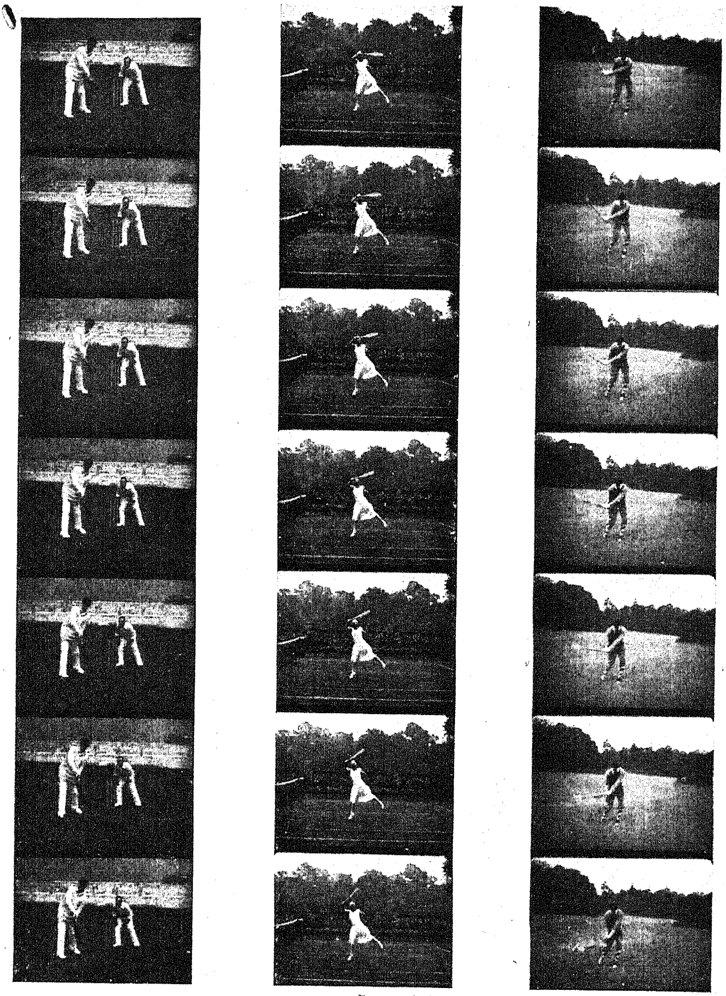


Fig. 10

to be taken instantaneously, as the horse was moving quickly. It passed in front of a white screen, and as the pictures were taken in bright sunlight they came out in black silhouettes, as shown in fig. 10. Copies of these photographs were sent to Paris, where someone put them into a Zoetrope, and they gave the impression of the horse moving. It was this experiment which suggested the cinematograph, in which a succession of photographs is taken of some moving object and then reproduced by means of a magic lantern.

It would have been impossible to move glass plates quickly enough in a camera, and as already stated, it was the introduction of the long celluloid film which made the cinematograph possible.

A long ribbon of positive pictures was made from the ribbon of negatives taken in the camera, and at



By permission of Messrs. Pathé Frères Cinema Ltd.

PORTIONS OF CINEMATOGRAPH FILMS

first there was no magic lantern. The pictures were viewed in an instrument through which they were passed in quick succession, standing still for a moment to be viewed and then jumping quickly to bring the succeeding picture into view.

Every boy and girl knows how the pictures are viewed nowadays on a lantern screen, the ribbon of positive prints being passed through a special magic lantern.

The film or ribbon of pictures is rolled on a large reel, and fed from this to another reel. The reels move at a regular rate, and the sudden jumps are made with the loose loop of the ribbon, which is easily started and stopped, as it has little weight.

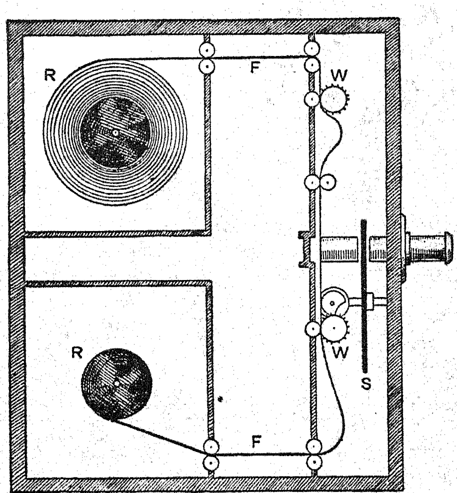


Fig. 11.—The Cinematograph Camera

The accompanying drawing (fig. 11) shows the loose loop of film marked F. It passes round two little wheels (W) having spikes on them. These spikes fit into holes in the edges of the film. S is the shutter for shutting and opening the lens at the correct time when taking photographs. The reels are marked R, and you can see how the ribbon passes in front of the lens on its way from the one reel to the other.

If the pictures are reproduced by the lantern at the same rate as that at which they were taken, we get a natural movement.

If we wish to have a slow-motion picture, then a much greater number of pictures are taken at a very quick rate and reproduced at a slower rate. They have to be quick enough to give the impression of a continuous motion, and that is why a much greater number of pictures have to be taken. If you merely worked an ordinary film at a slow rate it would give a jerking movement; it would not be continuous.

On the other hand, if it is desired to show the growth of a plant, a number of pictures must be taken at long intervals, giving the plant time to grow a little between the taking of the pictures. Then when the pictures, taken over many days, are reproduced in a few moments, you see the plants grow, the buds form, and the flowers open and wither.

Perhaps the slow-motion pictures are of greater interest, for in these you can see exactly what happens when a man dives into the water, or a horse jumps a hurdle, and many other movements.

CHAPTER XI

Photography and Book Pictures

Although the system of Niepce, in which he used bitumen of Judea, did not enable him to secure the image of the camera, it did serve a very useful purpose in leading up to the modern methods of printing photographs in books.

Very long ago the Chinese observed that if a block of wood was smeared over with ink, it would leave a clear impression of itself upon a piece of paper. This led to the idea of cutting the signs of their language in lines on the surface of the wood and then printing them on paper. The successful printing of these led the Chinese to cut pictures on wooden blocks and print them.

We do not know the date of the first printing of these wooden blocks, nor do we know the date on which this method was introduced into Europe, but we have some of these early prints dating back 500 years. They are preserved in our museums, and they are simple pictures made up of lines without any attempt at shading. Later, the art of wood-engraving improved immensely, and was used until photographic methods were invented. Before this came about there was hand engraving on metal plates. Indeed, this art is even older than the art of printing. Engravings were made in the days when books were written by hand.

The goldsmiths of Florence made beautiful engravings. When making ornamental vases they were accustomed filling the engraved lines with black enamel after the design had been completed. While at work they had difficulty in seeing the part of the design they had cut previously, so they used ink to fill the engraved lines on the vase; then, cleaning the surface of ink, they pressed a damp paper against the

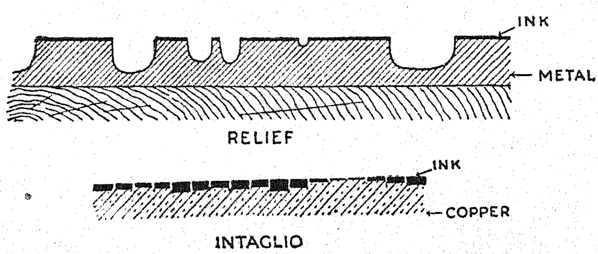


Fig. 12.—Relief and Intaglio Engraving

vase, and they obtained upon the paper a clear impression of the lines which they had cut. Some considerable time elapsed before it was suggested that pictures might be printed in this manner.

In this engraving on metal, the lines are cut into the metal, whereas in a wooden block the lines are left raised, as in printing type. We call them *relief blocks.* Plates which have the lines sunken below the surface are called *intaglio*, and it is evident that they must require a process of inking different from that which is required with relief blocks.

With the relief block you can easily ink the upstanding lines, but in putting ink into the sunken

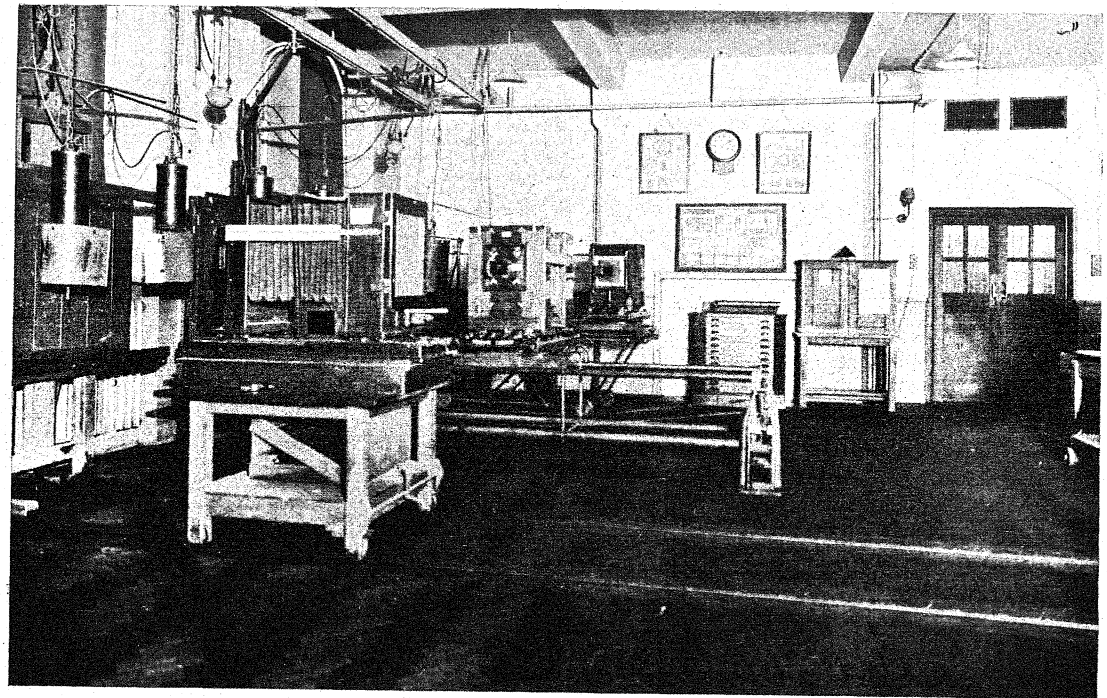


Photo by courtesy of the London County Council of Photo Engraving.

PHOTOGRAPHIC STUDIO OF A BLOCKMAKER

lines the surface of the plate will be inked also. It is therefore necessary, after dabbing on the ink, to clean the surface of the plate, and this process must be done by hand.

When a suitable paper is pressed against the engraved plate, with the ink in its sunken lines, the ink will be transferred from the lines to the surface of the paper, this being done by means of a hand press.

In order to print photographs into books by machinery, we must adopt the relief block with the raised lines, which may be easily inked by passing an inked roller over them.

You will remember that the plan adopted by Niepce was to cover the metal plate with bitumen of Judea, which is sensitive to light. When exposed to light it becomes insoluble, whereas if it has not been exposed to light, it will dissolve readily in oil of lavender. The action of the light altered the chemical condition of the bitumen.

Niepce exposed the bitumen of Judea on the metal plate, while it was covered by a glass on which there was a drawing. The parts of the plate under the black lines were protected by the lines so that these parts remained soluble, while the other parts which were exposed to light became insoluble. If the exposed plate were then placed in oil of lavender, the lines were dissolved, and the surface of the plate was exposed at these lines.

If this plate were then placed in a bath of acid, the acid could only get at the plate where these clear lines

were. The result was that the surface of the plate was eaten into at these lines, while the main body of the plate was protected by the undissolved bitumen. This gave an intaglio plate with sunken lines for receiving the ink, and afterwards transferring it to paper, but as already stated this is only suitable for hand-printing presses.

However, we can easily reverse the matter by arranging that the acid attacks the main body of the plate and leaves the lines upstanding from the lowered surface. This can be arranged by using a photographic negative instead of a drawing. You know that in the negative the lines of the drawing will be clear glass. This will let the light through the lines and they will become insoluble on the prepared plate. The main body of the plate will be attacked by the acid while the lines are protected. The result will be lines upstanding from the surface, or in other words a relief block.

In the blockmaker's workshop we find him taking photographs of line drawings which have been made by an artist. This gives him the necessary negative with the clear lines which he places over the prepared plate, and obtains a relief block in the manner already described.

This printing-block or *Zincotype* is usually made of the metal zinc, as it is inexpensive and is readily attacked by the acid. These blocks may be used in an ordinary printing-press just as type is used (fig. 13).

I remember how I learnt that the blockmaker uses photographs. Very many years ago I had written an

article for a science journal, and it was to be illustrated by some diagrams. Thinking that the blocks had to be made by hand, I scribbled certain descriptions on them, expecting these to be put in type. Imagine my surprise when I saw the article printed

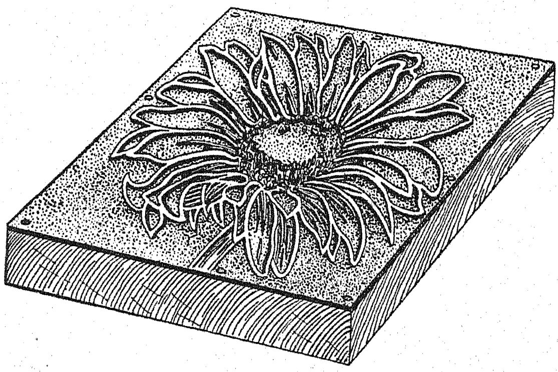


Fig. 13.—A Zinc Line Block

with all my scribbles, just as I had put them on the drawings. It was quite evident that the blockmaker had photographed the drawings and had made his blocks by means of these photographs.

We see how this method of Niepce enables us to use photographs in the making of printing blocks. You will understand, however, that it is quite a different thing to print a photograph in a book. We have only dealt with line drawings so far.

CHAPTER XII

Printing Photographs in Books

With the aid of light we might print a photograph on the prepared surface of a metal plate, but if we tried to use such a plate as a printing block, I think you can guess what would happen.

If we passed an ink-roller over the plate, the whole surface would accept ink, and if we tried to transfer this to paper we could only get what you might describe as a smudge. There would certainly be no appearance of a picture.

The relief block was successful because it had raised lines, which accepted the ink and transferred it to paper, while the main surface of the plate had no ink upon it.

In the days of wooden blocks, the French engravers of the fifteenth century introduced a new effect which they called *stippling*. This was additional to the lines forming the picture. Not only did they make these lines, but they made small upstanding dots which could accept ink and print dots in the pictures. In this way they got shaded effects. These raised dots were made of different sizes, in proportion to the amount of ink it was desired to transfer to the paper at any place.

This printing with small dots gave an idea for the printing of photographs. If we could form small

side of the room, you will see that they make quite good pictures of a child's face and an eye.

It would not be very convenient to have to view all pictures across a room, so we make the dots so small that you cannot see them even when you have the picture near at hand.

The photographs in this book contain dots just as in the pictures referred to, but you require a magnifying glass to see the dots.

It will be of interest to see how the photograph is produced and then printed in a book by means of this process, which we call the *half-tone process.*

The first thing is to produce the dotted negative, and to this end the block-maker takes a photograph of the photograph. He has placed in the camera a screen to produce the dots, but his camera does not seem to be pointing towards the photograph. On looking at the front of his camera, we see that the lens is bent round to look out, as it were, from the side of the camera, instead of looking straight in front. You know that light cannot of itself bend round a corner, but you may be able to guess that there is a mirror or a prism in the camera to do the necessary bending required to throw the light on to the photographic plate. This eccentric arrangement of the camera must be for some special purpose (fig. 17).

In an ordinary negative your right hand becomes your left hand, and then when you make a photographic print on paper, your left hand becomes your right hand, so that you get back to the original.

If the block-maker took a photograph in the ordinary way, he would get the right hand as the left hand in his negative. Then on printing on to the metal block, the left hand would again become the right hand, but he wishes to make another print-

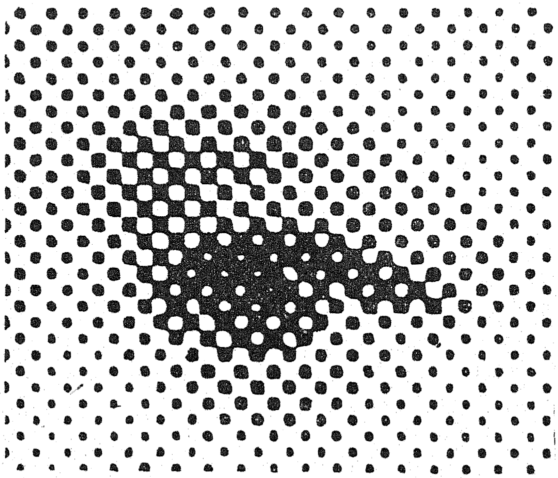


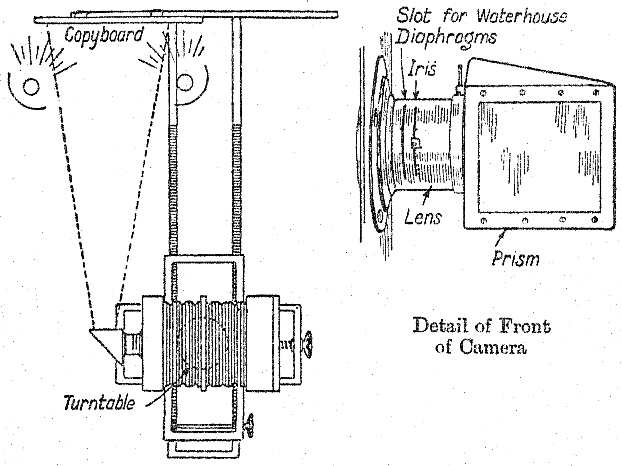
Fig. 16.—The Translation of Continuous Tone into Black and White Units by Half-tone Process

ing with ink, and so in the final picture the right hand would become the left hand. It is to correct this that he reverses the order of things in his taking of the negative.

In taking the negative through the screen, we may picture a myriad of little pencils of light each making a dot, the size of which will depend upon the amount of light at that place.

Suppose we are desirous of making a block of a photograph in which there is a man dressed in a black coat and having a white collar and shirt.

The white shirt front will reflect most light into the camera, and the pencils of light passing through



Plan

Detail of Front of Camera

Fig. 17.—Process Camera. See also plate facing page 64

the screen will form large dots on the negative. This is the reverse of what we wish, but serves our purpose very well, as we are going to make a positive print on the metal plate.

The man's face will reflect rather less light than the white shirt front, so the pencils will not make quite such large dots, while the black coat will reflect very little light, and the result will be very small

dots on the negative turned into large dots on the positive.

Having secured the dotted positive print from the dotted negative, by placing the negative on the prepared surface of the metal plate, it is treated in an etching bath as in the case of the line blocks. The result is it is eaten into by the acid except where it is protected by the dots; when the plate comes out of the acid bath, there are myriads of little upstanding dots on its surface.

This metal plate is then mounted on a wooden block, and used in the printing machine as though it were ordinary type.

When the ink-roller passes over it the dots accept ink, which they transfer to the surface of the paper. In this way are photographs reproduced in books.

QUESTIONS

CHAPTER I

1. State the derivation of the word *photography.*
2. What name was used before photography?
3. What was light supposed to be, many years ago?
4. What is light?
5. What is heat? State two different kinds of heat.
6. What are infra-red waves?
7. To what are different colours due?
8. What is colour?
9. How are the colours produced in colour photography?
10. What is a negative, and how do positives result from it?
11. Mention a proverb that speaks of positive and negative.

CHAPTER II

1. About how long did the camera exist before photography was invented?
2. What was the use of the early cameras?
3. What were they called, and why were they so called?
4. Why is the image inverted in a camera?
5. Why did they not use a larger hole to admit more light into the early cameras?
6. How did they succeed in admitting more light?
7. In what way did they view the pictures in proper position in the cameras?
8. To what practical purposes were the early cameras put?
9. Where may one of this early style of camera still be seen?
10. How may such camera pictures be produced by accident?
11. Where are such pictures common occurrences?

CHAPTER III

1. Tell the story told by a French novelist of light forming a picture.
2. State some points of similarity between the process related in the story and the actual process of photography.
3. Mention the general principles of photography.
4. What two factors determine the length of exposure to be given to the photographic plate?
5. What are "stops"? What suggested these?
6. How long did one gentleman take to photograph an Abbey? How did he require this time?
7. Explain the meaning of the words "latent image".

CHAPTER IV

1. For what purpose did the alchemists practise chemistry?
2. What did Sir Isaac Newton write to a friend in connexion with alchemy?
3. How old was Newton at this time?
4. Describe a discovery made in 1727 which was the first step towards photography.
5. By whom was this discovery made, and what was the profession of the discoverer?
6. How did he fail when he tried to repeat the experiment?
7. What was the next step in the evolution of photography?
8. What was the date of this second step?
9. Mention some other persons who made further experiments, and what of special interest did they attempt?
10. What was the Lunar Society, and why was it so named?
11. Mention some distinguished members of the above society, and state how they became famous?

CHAPTER V

1. To what country does the invention of practical photography belong?
2. What were the French photographs called?
3. Who may be considered the real inventor of practical photography?
4. What was the camera lucida used for, and wherein did it differ from a camera obscura?
5. What did Talbot say concerning the camera lucida?
6. What did he say concerning drawings made in the camera obscura?
7. Give Talbot's description of the pictures produced by a camera obscura.
8. State Talbot's description of how a camera picture might be made permanent.
9. When did Talbot first take an interest in the subject?
10. What sort of photographs did he attempt at first, and what chemicals did he use?
11. What is the chemical name for salt, and of what is it composed?
12. State the peculiarity of one of the components (the substances composing the salt).
13. What was the title of the first of Fox Talbot's books, and how did he illustrate it?
14. What was the title of his second book, and where did the author find a copy of it?

CHAPTER VI

1. Who made the first step towards photography in France?
2. What substance did the inventor use and why did he use it?
3. What did he try to do with his process?
4. Describe the process.
5. What pictures did he try to secure by his process?

6. Who else became possessed of the same idea, and what was his profession?
7. How did these two inventors get to know each other?
8. Relate an incident which took place in an optician's shop, referring to what we believe to be the first photograph.
9. Was the agreement between the two inventors cancelled by the death of one of them?
10. Describe the difference between the two inventors' processes.

CHAPTER VII

1. What length of exposure had to be given in the attempt to secure photographs in the early days?
2. Tell of the discovery of the latent image.
3. How did the inventor discover the good fairy?
4. What were these early photographs called?
5. Describe how these were produced.
6. How was the plate developed?
7. Why was it mounted in a covered frame?
8. With what other pictures are they sometimes confused?

CHAPTER VIII

1. What caused Daguerre to announce his invention?
2. To whom did he show his pictures?
3. What proposals were made in the Chamber of Deputies?
4. What was said of Daguerre's discovery?
5. Did Daguerre keep faith with the Chamber of Deputies?
6. What is the probable reason for Daguerre patenting his invention in Great Britain?
7. Describe the taking of a photograph in the early days.
8. What did the advertisement say of the head rest?
9. Where were the first attempts at portraiture made?
10. What was the shortest exposure at that time?

CHAPTER IX

1. State the names of four Englishmen who helped in the evolution of photography.
2. Describe the discovery of the latent image in a paper negative, and state the date of the discovery.
3. To what conclusion did the discoverer come regarding the production of the visible picture from the latent image?
4. What did he say of the gradual appearance of the pictures?
5. What royal personages practised the early photography?
6. Where had they a dark room fitted up?
7. What name did this process bear at that time?

CHAPTER X

1. What was the paper negative replaced by?
2. Of what was the film, for supporting the chemicals, made?
3. What followed as an improved supporting film?
4. When did the dry plate come into practice?
5. What helped in the production of a sharper image?
6. A new substance was used to carry the supporting film; of what was it made? What were its great advantages? In what form is it carried?
7. What invention did it make possible?
8. How did this invention come about?
9. Describe (*a*) a thaumatrope, (*b*) a phenakistoscope.
10. Give the derivation of these two names.
11. What is a zoetrope?
12. Give the derivation of the word *zoetrope*.
13. Describe a cinematograph lantern.
14. How are slow-motion pictures produced?
15. How may a plant be seen to grow?

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CHAPTER XI

1. To what did Niepce's process lead up?
2. What did the Chinese discover and put to a practical use?
3. What were the processes of printing prior to the introduction of photography?
4. What was suggested by the work of the goldsmiths of Florence?
5. Describe (*a*) relief blocks, (*b*) intaglio.
6. Which process is adopted for printing pictures in books, and why?
7. Describe how photography aids the blockmaker.
8. How did the author first know that photography was being used to produce diagrams?

CHAPTER XII

1. What does the relief block do with the ink?
2. What is stippling, and what may it produce?
3. For what purpose is the light passed through a screen in connexion with blockmaking?
4. What name is given to the process for printing photographs?
5. Describe the taking of a photograph for blockmaking.
6. Describe the production of the negative.
7. Describe the process from the negative to the printed picture.